Natural Limits for Currents in Charge Separated Pulsar Magnetospheres A. Jessner1, H. Lesch 2 T. Kunzl2 Max–Planck–Institut für Radioastronomie, Radio-Observatorium Effelsberg, Max-Planck-Str. 28, D-53902 Bad Münstereifel, Germany Centre for Interdisciplinary Plasma Science

abstract Rough estimates and upper limits on current and particle densities form the basis of most of the canonical pulsar models. Whereas the surface of the rotating neutron star is capable of supplying sufficient charges to provide a current that, given the polar cap potential, could easily fuel the observed energy loss processes, observational and theoretical constraints provide strict upper limits to the charge densities. The space charge of a current consisting solely of particles having only one sign creates a compensating potential that will make the maximum current dependent on potential and distance. In the non-relativistic case this fact is expressed in the familiar Child-Langmuir law. Its relativistic generalization and subsequent application to the inner pulsar magnetosphere provides clear limits on the strength and radial extension of charged currents originating on the polar cap. Violent Pierce-type oscillations set in, if one attempts to inject more current than the space charge limit into a given volume. These considerations apply wherever there is a significant amount of charged current flow, in particular in the gap regions. There they can be used to derive limits on the size of such gaps and their stability.